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STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

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MEMORANDUM
November 2, 1982

To: Jonathan Neel, WDOE S.W. Region District Engineer

From: Tim Determan, WDOE Water Quality Investigations Section

Subject: Water Quality Characteristics Within the Dilution Zone below the Cowlitz County Water Pollution Control Plant Outfall

INTRODUCTION

During September 1-3, 1982, a dilution and dispersion study was performed on the Columbia River below the Cowlitz County Water Pollution Control Plant near Longview (Figure 1). The purpose was to obtain, as you requested, information on the quality of river waters in the dilution zone that WDOE has designated for this facility. It is understood that these data will be used to determine whether appropriate water quality standards are being met and provide a basis for determining if a diffuser is needed for the new outfall system.

The need for the survey arose due to the destruction of the outfall during dredging of sediments deposited in the Cowlitz and Columbia rivers as a result of the eruption of Mt. St. Helens. Although the Army Corps of Engineers is willing to replace the diffuser, a saving in funds would result if it were determined that water quality standards are achieved under present conditions.

The Cowlitz County Water Pollution Control Plant is a secondary sewage treatment facility located in the Longview-Kelso industrial area. The discharge site is located about a mile from the treatment plant on the north bank of the Columbia River and immediately downstream from the mouth of the Cowlitz River (Figure 1). The discharge line passes through Longview Fibre Company property lying next to the river bank. A discharge from the Longview Fibre Company lies about 850 feet upstream of the domestic discharge (Stevens, Thompson and Runyan, Inc., 1972). Several dolphins and an oil pier are found immediately downstream.

DILUTION ZONE AND WATER QUALITY STANDARDS

For reference, the existing diultion zone requirements for the Cowlitz County treatment facility as defined by WDOE based on guidelines given by CH_2M Hill, Inc. (1980) are:

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1. The dilution zone boundary shall be a minimum of 100 feet from the water line at low flow (low flow is interpreted as low river flow during lower low water tide state);

2. The dilution zone shall extend from the river bottom to within 1.0 foot of the surface;

3. The dilution zone shall extend 300 feet downstream from the outfall; and

4. The dilution zone shall extend 50 feet on either side of the outfall.

The Columbia River is classified as Class A according to the state Water Quality Standards (Chapter 173-201 WAC), as follows:

WAC 173-201-080 Specific Classifications - Freshwater

"(21) Columbia River from mouth to the Washington-Oregon border (river mile 309). Special conditions - water temperatures shall not exceed 20.0° Celsius due to human activities. When natural conditions exceed 20.0° Celsius (freshwater), no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3° Celsius; nor shall such temperature increases, at any time, exceed 0.3° Celsius due to any single source or 1.1° Celsius due to all such activities combined. Dissolved oxygen shall exceed 90 percent of saturation."

In addition to the special conditions identified above, several other applicable standards apply, as folllows:

1. Fecal coliform organisms shall not exceed a geometric mean value of 100 organisms/100 mL, with not more than 10 percent of samples exceeding 200 organisms/100 mL.

2. pH shall be within the range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a man-caused variation within a range of less than 0.5 units.

3. Toxic, radioactive, or deleterious material concentrations shall be below those of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water use.

There are no specific numerical standards for ammonia or nutrients. However, EPA (1976) recommends that un-ionized ammonia (NH_3-N) in freshwater not exceed 0.02 mg/L since the un-ionized form is recognized as toxic.

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METHODS

A reconnaissance was performed on September 1, 1982. During this effort, the outfall line was located and followed to its approximate terminus. An anchor with a tethered line and buoy was placed near the end. The depth at this point was about 10m or 33 feet at lower low water (LLW) (Longview/Kelso tide station, NOAA, 1982). The gradient of the bottom increased rapidly from this contour outward, probably due to dredging. An additional anchored float was placed along the line shoreward near the point where the buried discharge line emerged from the sediments.

Prior to carrying out intensive sampling, an independent attempt was made to confirm the discharge location by dropping 250 mL of Rhodamine WT flourescent dye into the wetwell at the treatment plant. The outfall line is 42 inches in diameter and is about 6100 feet long with an estimated travel time of 2 hours. The dye was dropped at 0815. Careful watch was kept until noon. The dye never emerged in the receiving waters in concentrations sufficient to be seen.

On shore, I took a compass bearing from a manhole located along the discharge line about 400 feet south of a small sign at the top of an oil storage tank containment berm along shore (Figure 1). The sign marked the location of the sewer line. We measured the bearing of the line with a Weems hand-bearing compass (187° Mag.). We noted a landmark on the other side of the river (a 30-foot brick chimney on the Rainier, Oregon Elementary School) in line with the marker sign. The two tethered buoys along the outfall pipe lined up quite well with the manhole/sign/chimney bearing line. This confirmed that the discharge pipe had been located.

In order to pinpoint the location of the end of the pipe and to determine its approximate distance offshore, some trigonometric methods were applied. First, a 250-foot (75m) base line was measured westward parallel to the roadbed on top of the containment berm. Angles were then measured with a Tamaya navigational sextant between the reference buoy at the end of the outfall pipe and each end of the base line (Figure 1). The Law of Sines (Spitzbart and Bardell, 1964) was used to calculate the distance from the sign at the top of the berm to the reference buoy. An upstream correction was calculated to account for the downstream displacement of the buoy by the river flow. This correction was determined by the Pythagoran Theorem using the depth (33 feet or 10m) and the length of buoy line (66 feet or 20m).

Dilution zone sampling was performed on September 2, 1982. In order to evaluate dilution and dispersion within this zone, stations were established downstream from the outfall (Figure 1). The downstream stations were marked by a 300-foot floatable line (polypropelene) secured to the reference buoy. It was assumed that the flow field was uniform in

velocity and unidirectional at all depths. Marker buoys for sampling were placed at 150-foot (45m) intervals along the line. The tethered line generally lined up parallel to shore. A control station was located about 300 feet upstream from the reference buoy. Normally the upstream station would contain wastes from Longview Fibre Company. However, the paper plant was not discharging at the time of the survey (Jerry Schultz, Cowlitz County WPCP chemist, personal communication).

All variables except fecal coliform (FC) and nutrients were measured in the field using a Hydrolab System 8000 in situ analyzer. Specific conductivity was used to trace the plume. Hydrolab readings were taken at two-meter intervals from the surface to the bottom at each station. Hydrolab variables included specific conductance, temperature, dissolved oxygen (D.O.), pH, and depth. Samples for laboratory variables were obtained using a three-liter Kemmerer water sampling bottle. Laboratory variables included FC and nutrients. Fecal coliform samples were taken at the surface and at the greatest depth at each station. FC sample bottles and laboratory analyses was provided by staff from the Cowlitz County Water Pollution Control Plant. Ammonia samples (and other nutrients) were sampled at the surface, mid-depth, and at greatest depth. Analysis was provided by the WDOE Environmental Quality Laboratory using procedures from APHA (1980) and EPA (1979).

A chlorine survey was carried out on September 3, 1982. Samples were obtained at the outfall reference buoy, about 150 feet downstream and about 300 feet upstream. Samples were obtained from the surface and from bottom waters using the Kemmerer sample bottle. The samples were analyzed within an hour after the first sample was taken in the laboratory of the Cowlitz County Water Pollution Control Plant using a Chlortect Chlorine Monitor.

Laboratory analyses conformed to methods given by APHA (1975) and EPA (1979). Percent saturation values for oxygen were calculated using conversion factors and saturation values from UNESCO (1973).

RESULTS AND DISCUSSION

As a result of the survey methods discussed earlier, the discharge point was located about 335 feet out from the marked sign at the top of the fuel tank containment berm (Figure 1). An upstream correction of 56 feet was applied to account for downstream displacement of the buoy.

Table 1 shows little evidence of discharge effects at any depth within the discharge zone when compared to the background (upstream) station. There appears to be no significant change in temperature, conductivity, D.O. (Winkler), fecal coliform, or nutrients. Nitrite was below detection limits at all sites. Total ammonia appeared to be higher at the control site than in the discharge zone. All applicable water quality standards and special conditions were met within the discharge zone at the time of our survey.

Dissolved oxygen measurements taken by the Hydrolab appeared to be elevated relative to the Winkler values in the bottom waters at the stations 150 feet and 300 feet downstream from the outfall. The cause is unknown. The chlorine survey conducted the following day showed no chlorine in the vicinity of the discharge. However, the treatment plant may have been discharging little chlorine at the time (0.3 mg/L, Table 1) since the chlorine tank was nearly empty. Considering the time of travel of the effluent in the discharge line, it would be surprising if any chlorine residual were detectable even under normal chlorination conditions.

During the survey, I observed along the north bank, a band of surface water of greater turbidity than the rest of the river. This was most likely Cowlitz River water which impinged on the north bank by the Columbia River flow. The width of the Cowlitz River band ranged from about 450 feet during maximum velocities during dropping tide to approximately 600 feet during low slack tide when the Columbia River flow velocity appeared minimum. We might assume, therefore, that the treated effluent is discharged into a relatively narrow (relative to the width of the Columbia River) flow field that is largely made up of Cowlitz River water. During the period of record (56 years), the U.S. Geological Survey has recorded a minimum flow of 998 cubic feet per second (cfs) at Castle Rock (1935). During the past five years, September river flows have ranged from 2756 to 4593 cfs (U.S. Geological Survey, 1977-1979; Ollie Heddick, USGS, personal communication).

By converting the minimum Cowlitz River flow for the period of record, we have 645 million gallons per day (MGD). If we assume minimum mixing with the Columbia River, the ratio of effluent:minimum Cowlitz River flow is 6 MGD/645 MGD or less than one percent. Under higher flow conditions and turbulent mixing with the Columbia River, the ratio would be considerably lower.

Bernhardt (1981) used a relationship to estimate the fraction of wastewater in receiving waters near a treatment plant outfall:

$$\%e = \frac{Cs-Cu}{Ce-Cu} \cdot 100$$

where: %e = percentage of effluent in the receiving water
Cs = concentration of a conservative tracer in the receiving water
Cu = concentration of the tracer in the receiving water upstream of the discharge
Ce = concentration of the tracer in the effluent

Table 2 shows the distribution of wastewater in the vicinity of the discharge. Specific conductance was used as the conservative tracer.

Treated effluent accounts for less than one percent of the receiving waters. No downstream changes are apparent since the values are subject to variation.

CONCLUSIONS

The effects of the discharge from the Cowlitz County Water Pollution Control Plant were not discernible in the dilution zone. This may be because the volume of the plant is very small in comparison to the large volume of receiving water flowing past the point of discharge. The percentage of effluent in the discharge zone was found to be less than one percent at any point.

The effects of other materials, such as metals, organics, and other toxics may be an issue. However, they were not addressed in this study.

It is important to emphasize that the results reflect conditions as they existed at the time of the survey. Population increases or more intensive industrial land use in this area will undoubtedly increase regional loads on the Cowlitz and Columbia rivers. This fact should be carefully considered before a decision is reached in the matter of replacing this outfall-diffuser. However, under present conditions, a single point discharge provides adequate initial dilution.

TAD:cp

cc: Dick Cunningham
John Bernhardt
Section Files

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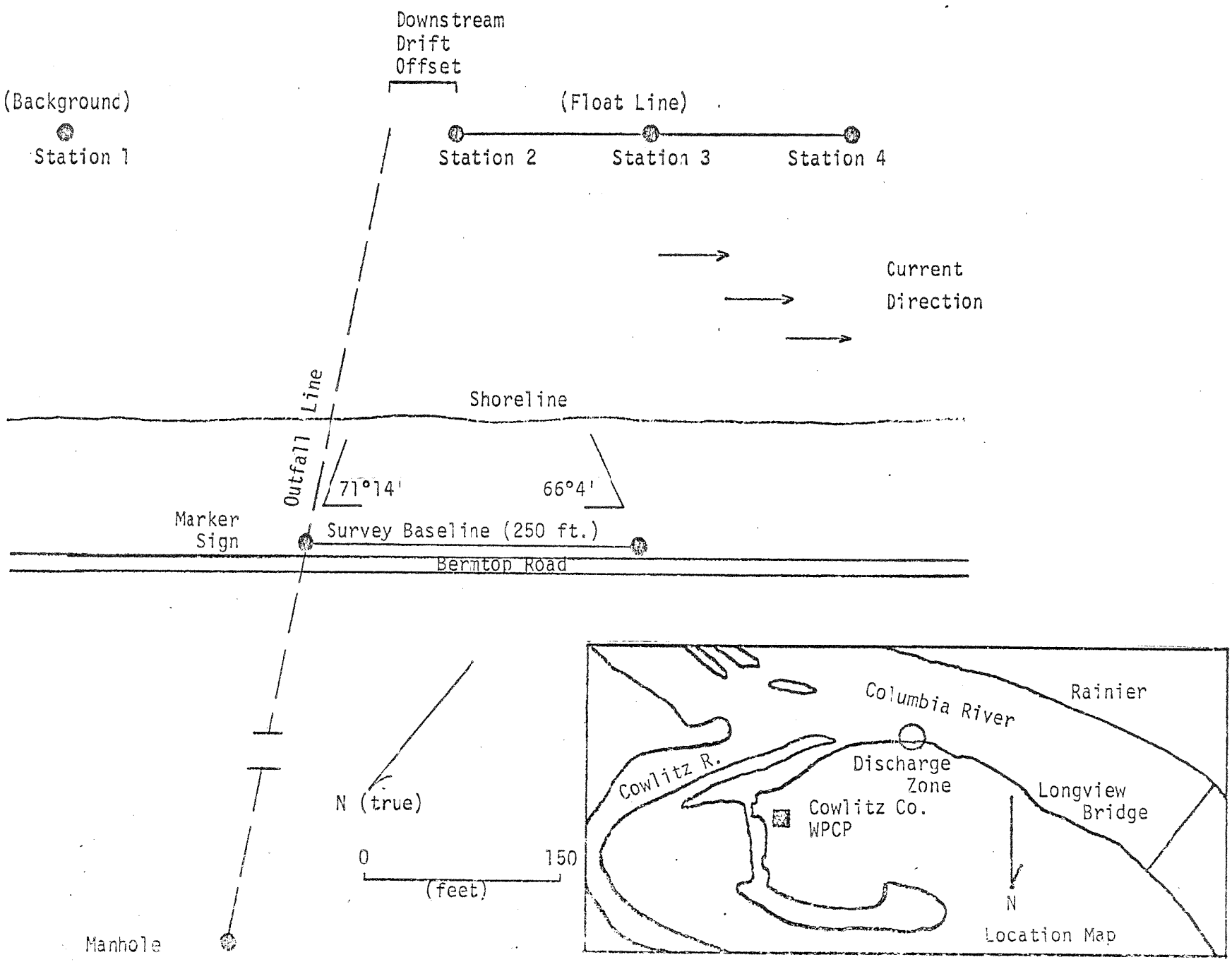

Figure 1. Cowlitz Co. WPCP discharge zone showing location of sampling points and survey points.

Table 1. Summary of water quality data obtained during monitoring at the Cowlitz County water pollution control plant outfall on the Columbia River.

		Field Measurements					Laboratory Measurements							
Station Number	Station Description	Depth (m)	Temperature (°C)	Cond. (umhos/cm)	pH (units)	DO-HYDRO (mg/L) (% sat.)	DO-TITR (mg/L)	Fecal Coliform (org/100 ml)	NH_3-N[1/] (mg/L)	NO_2-N[1/] (mg/L)	NO_3-N[1/] (mg/L)	O-PO_4-P[1/] (mg/L)	T-PO_4-P[1/] (mg/L)	Cl_2-resid. (mg/L)
	Plant Effluent	--	20	384	6.9	--	--	20	0.35[2/]	0.2[2/]	2.3[2/]	3.5[2/]	4.0[2/]	0.3
1	Approx. 300 ft. upstream from No. 2 (Control)	0	20.7	117	7.32	9.0(100.5)	9.0	14[2/]	0.04 ± 0.01	<0.01	0.05 ± 0.00	0.02 ± 0.00	0.04 ± 0.00	0.0
		2	20.6	117	7.28	8.6(95.9)	--	--	--	--	--	--	--	--
		4	20.4	118	7.23	9.2(102.3)	--	--	0.04 ± 0.01	<0.01	0.05 ± 0.00	0.02 ± 0.00	0.05 ± 0.00	--
		6	20.2	117	7.13	9.4(104.0)	--	--	--	--	--	--	--	--
		8	19.6	119	6.98	9.4(103.9)	9.1	22[2/]	0.06 ± 0.04	<0.01	0.04 ± 0.00	0.04 ± 0.01	0.06 ± 0.01	0.0
2	Outfall Site	0	20.8	119	7.47	8.6(96.3)	9.0	24[2/]	0.03[2/]	<0.01	0.04 ± 0.00	0.02 ± 0.00	0.04 ± 0.01	0.0
		2	20.6	119	7.43	9.0(100.4)	--	--	--	--	--	--	--	--
		4	20.6	119	7.42	9.0(100.4)	--	--	0.02 ± 0.01	<0.01	0.04 ± 0.00	0.01 ± 0.00	0.02 ± 0.01	--
		6	20.5	119	7.42	9.1(101.3)	--	--	--	--	--	--	--	--
		8	20.5	120	7.31	8.4(93.5)	8.9	28[2/]	0.04 ± 0.01	<0.01	0.05 ± 0.01	0.02 ± 0.00	0.04 ± 0.01	0.0
3	150 ft. downstream from Stn. No. 2	0	20.9	119	7.44	8.6(96.5)	8.9	40[2/]	0.02 ± 0.01	<0.01	0.04 ± 0.00	0.01 ± 0.00	0.04 ± 0.01	0.0
		2	20.6	120	7.41	9.9(100.4)	--	--	--	--	--	--	--	--
		4	20.5	120	7.40	10.3(114.7)	--	--	--	--	--	--	--	--
		5	--	--	--	-- --	--	--	0.03 ± 0.01	<0.01	0.05 ± 0.00	0.02 ± 0.00	0.03 ± 0.01	--
		6	20.6	120	7.40	11.1(123.8)	--	--	--	--	--	--	--	--
		8	20.6	120	7.41	11.7(130.5)	--	--	--	--	--	--	--	--
		10	20.6	120	7.39	10.5(117.1)	8.8	22[2/]	0.03 ± 0.01	<0.01	0.02 ± 0.00	0.02 ± 0.00	0.05 ± 0.01	0.0
4	300 ft. downstream from Stn. No. 2	0	20.7	118	7.41	8.7(97.1)	9.0	12[2/]	0.03 ± 0.03	<0.01	0.05 ± 0.00	0.02 ± 0.01	0.03 ± 0.00	0.0
		2	20.4	119	7.39	9.8(108.9)	--	--	--	--	--	--	--	--
		4	20.5	119	7.38	10.4(115.8)	--	--	--	--	--	--	--	--
		5	--	--	--	-- --	--	--	0.02 ± 0.00	<0.01	0.05 ± 0.00	0.02 ± 0.01	0.04 ± 0.01	--
		6	20.4	119	7.38	11.8(131.2)	--	--	--	--	--	--	--	--
		8	20.3	119	7.36	11.2(124.3)	--	--	--	--	--	--	--	--
		10	20.1	120	7.33	11.4(125.9)	9.0	22[2/]	0.01 ± 0.00	<0.01	0.05 ± 0.[illegible]	0.02 ± 0.00	0.04 ± 0.00	0.0

[1/] Data are shown as $\bar{X} \pm S$ from replicates.

[2/] One sample only.

Table 2. Distribution of percentage of wastewater in the dilution zone below the Cowlitz County water pollution control plant outfall.

Station Number	2		3		4	
Station Description	outfall site		150 feet downstream from station 2		300 feet downstream from station 2	
Depth	Cs/ Cu/ Ce	%c	Cs/ Cu/ Ce	%c	Cs/ Cu/ Ce	%c
0	119/117/384	0.75	119/117/384	0.75	118/117/384	0.37
2	119/117/384	0.75	120/117/384	1.12	119/117/384	0.75
4	119/118/384	0.38	120/118/384	0.75	119/118/384	0.38
6	119/117/384	0.75	120/117/384	1.12	119/117/384	0.75
8	120/119/384	0.38	120/119/384	0.38	119/119/384	0.00
10	120/119/384	0.38	120/119/384	0.38	120/119/384	0.38